VOL. 12, No. 8 AUGUST, 1935

The AMERICAN JOURNAL *of* OPTOMETRY

EDITORS

CAREL C. KOCH JACK I. KURTZ

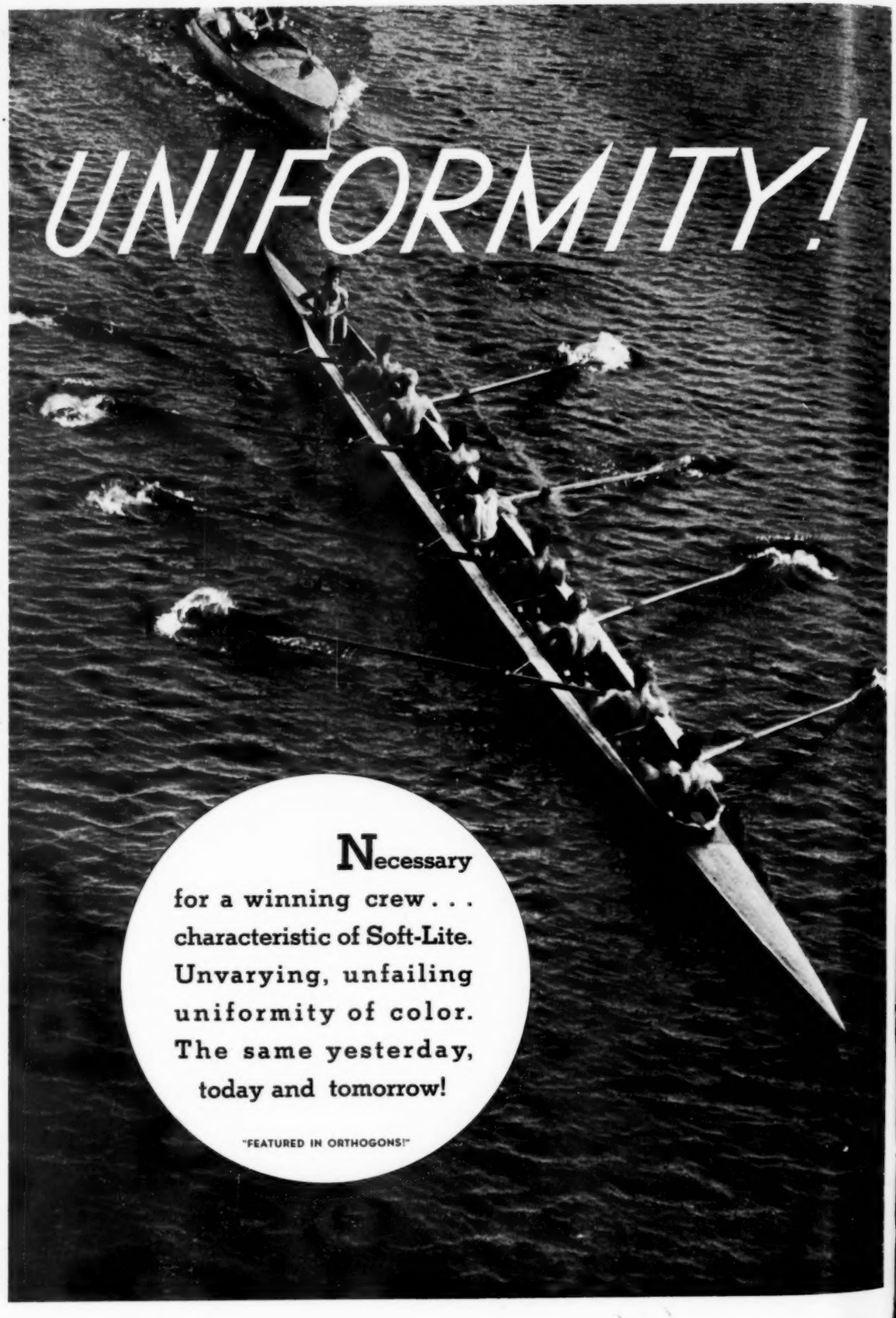
COLLABORATORS

E. B. Alexander, *Duncan, Okla.*
Earl Allgaier, *Ames, Iowa*
J. Fred Andreae, *Baltimore, Md.*
J. O. Baxter, Jr., *New Bern, N. C.*
J. O. Baxter, Sr., *New Bern, N. C.*
L. L. Beacher, *New York, N. Y.*
Robt. T. Best, *Fairmont, Minn.*
W. I. Brown, *New Bedford, Mass.*
J. T. Campbell, *Washington, N. C.*
Brant Clark, *Los Angeles, Calif.*
J. Robinson Cohen, *New York, N. Y.*
Paul Dill, *Greeley, Colo.*
Howard C. Doane, *Boston, Mass.*
J. H. Drakeford, *New York, N. Y.*
G. L. DuPlessis, *Minneapolis, Minn.*
T. H. Eames, *West Somerville, Mass*
Wm. Feinbloom, *New York, N. Y.*
L. P. Folsom, *South Royalton, Vt.*
Haley Lee Fording, *Portland, Ore.*
F. W. Freeman, *Anderson, Ind.*
M. Gilbert, *Owosso, Mich.*
W. H. Glazer, *Philadelphia, Pa.*
R. M. Hall, *Cleveland, Ohio*
C. J. Hathaway, *Pontiac, Mich.*
C. K. Haynes, *Jamestown, N. Y.*
Norman B. Hays, *Niagra Falls, N. Y.*
W. Jerome Heather, *Chicago, Ill.*
A. E. Hoare, *Los Angeles, Calif.*
H. S. Horton, *Cleveland, Ohio*
E. E. Hotaling, *New York, N. Y.*
Charles E. Jaeckle, *Newark, N. J.*
C. H. Johnson, *Philadelphia, Pa.*
H. D. Judd, *Detroit, Mich.*
B. E. Kehl, *St. Louis, Mo.*
L. H. Kraskin, *Washington, D. C.*
Alvhh R. Lauer, *Ames, Iowa*
C. V. Lyons, *San Francisco, Calif.*
G. A. MacElree, Jr., *Phila., Pa.*
F. L. Mason, *Berkley, Calif.*
D. J. Mayer, *Riverside, Calif.*
O. L. McCulloch, *Holyoke, Mass.*
F. McFadden, *Rutland, Vt.*
O. J. Melvin, *Omaha, Nebr.*
William B. Needles, *Chicago, Ill.*
J. C. Neill, *Philadelphia, Pa.*
J. F. Neumueller, *Woodbury Heights, N. J.*
Geo. D. Oertel, *Syracuse, N. Y.*
G. O. Ohlsson, *Detroit, Mich.*
C. R. Padelford, *Fall River, Mass.*
D. R. Paine, *Topeka, Kansas*
J. I. Pascal, *New York, N. Y.*
R. J. Pearce, *Greensboro, N. C.*
R. M. Peckham, *Rochester, N. Y.*
Geo. A. Perkins, *Ord, Nebr.*
Ernest Petry, *Rochester, N. Y.*
Harry E. Pine, *Chicago, Ill.*
S. H. Robinson, *Prescott, Ariz.*
E. LeRoy Ryer, *New York, N. Y.*
H. Leslie Salov, *Newark, N. J.*
Z. J. Schoen, *University, Viriginia*
Charles Sheard, *Rochester, Minn.*
Carl Shephard, *Chicago, Ill.*
R. E. Simpson, *Pasadena, Calif.*
William Smith, *Dorchester, Mass.*
H. Riley Spitler, *Eaton, Ohio*
M. Steinfeld, *Paducah, Ky.*
Edwin F. Tait, *Philadelphia, Pa.*
William J. Tait, *Philadelphia, Pa.*
W. O. Vivian, *Media, Pa.*
R. N. Walker, *Winston-Salem, N. C.*
A. P. Wheelock, *Des Moines, Iowa*
A. Whitaker, Jr., *Bridgetown, N. J.*
E. G. Wiseman, *Buffalo, N. Y.*
Arene T. Wray, *Los Angeles, Calif.*
Lloyd K. Wyatt, *Peoria, Ill.*

Published Monthly by the American Journal of Optometry Publishing Association,
1501 Foshay Tower, 821 Marquette Ave., Minneapolis, Minn.

ANNUAL SUBSCRIPTION $4.00. CANADA AND FOREIGN $5.00.

Entered as second-class matter February 20, 1924, at the postoffice at Minneapolis, Minnesota, under the Act of March 3, 1879.


UNIFORMITY!
Necessary for a winning crew . . . characteristic of Soft-Lite. Unvarying, unfailing uniformity of color. The same yesterday, today and tomorrow!
"FEATURED IN ORTHOGONS!"

AMERICAN JOURNAL OF OPTOMETRY

Vol. 12 AUGUST, 1935 No. 8

CONTENTS

ORIGINAL PAPERS
The Relationship of Anisometropia and Eyedness. Thomas Harrison Eames 295
Refractive Work at the London Refraction Hospital. D. W. A. Mitchell . . . 301
A Basic Technique in Orthoptics. Part Two. William Smith 321

EDITORIALS
The Development of Myopia 332

BOOK NOTICES
Ophthalmoscopy, Retinoscopy and Refraction. F. A. Fisher 335

ANNOUNCING THE SECOND ANNUAL

GRADUATE COURSE FOR OPTOMETRISTS

to be given at

THE UNIVERSITY OF MINNESOTA

September 22, 23 and 24

This course was arranged at the request of many optometrists who attended a similar course given at the university last year, and who are genuinely interested in the scientific advancement of optometry.

We were successful in securing for this course a number of practitioners and university professors who are specialists in their respective fields.

This course is given under the auspices of the

MINNESOTA ACADEMY OF OPTOMETRY

and the

AMERICAN JOURNAL OF OPTOMETRY

A complete program will be found on page V.

A limited number only will be registered.

REGISTRATION FEE $5.00

For registration use this application blank

American Journal of Optometry,
Foshay Tower, Minneapolis, Minn.

Please find enclosed check for $2.00 to cover part of my registration fee for the Graduate Course for Optometrists. I will pay the balance of $3.00 at the registration desk. It is understood that you will notify me in case the class is all filled up by the time my application reaches you. Send notice to:

Name.....

Street.....

City and State.....

READY FOR SCHOOL

In a few weeks from now, twenty-five million youngsters, tanned and fresh from a summer in the open, will go trooping back to school. And in every five of these, one will need glasses. What an opportunity for service there is here for every eyesight man in the country.

For this great group of boys and girls, the American Optical Company has designed three brand-new frames, named "Skippy" after that lovable, nine-year-old rascal-philosopher of the comic strips.

Every day more and more parents are realizing their duties to their children in the matter of eyes. School opening is the time when that duty is strongest. Never before have you had glasses made especially for youngsters, and with a name that gives them a pleasing personality for children.

Get Ready For School With "Skippy" Frames

AO American

AMERICAN JOURNAL OF OPTOMETRY

Vol. 12 AUGUST, 1935 No. 8

THE RELATIONSHIP OF ANISOMETROPIA AND EYEDNESS*

Thomas Harrison Eames, Opt.D.
West Somerville, Mass.

Investigators in other fields have regarded eyedness as one of several manifestations of cerebral dominance, giving less attention than is warranted to anisometropia as a conditioning factor. While eye dominance is probably determined by structural and functional conditions in the brain it is likely that the functional conditions may be influenced by various extra cerebral influences, not the least of which is anisometropia. This study was made in order to direct more attention to this aspect of the etiology of eye dominance as well as for the purpose of bringing out some of the fact relative to the conditioning of eyedness by refractive influences.

Two hundred ninety individuals were given complete eye examinations and of these one hundred thirty-seven were found to be anisometropic. Seventy-nine were males and fifty-eight were females. The age range of the entire group was from three to eighty years. The range among the males was from five to fifty-nine years, and among the females from three to eighty years. All cases in the study presented clear refractive media on ophthalmoscopic examination.

The anisometropic cases were divided into two groups. Group I comprised all cases in which the refractive error was lower in the dominant eye; the condition that would be expected when anisometropia predisposes to dominance of the better eye. This group included sixty-four and nine-tenths per cent of all the anisometropic cases. It was subdivided into right eyed and left eyed sub-classes. The right eyed sub-class was found to be forty-two and three-tenths per cent, and the left eyed sub-class twenty-two and six-tenths per cent of the total number of cases of anisometropia.

Group II included all cases of anisometropia not fulfilling the requirements of Group I. It was subdivided into two classes and four sub-classes. Class A included those cases in which the *higher* refractive error was in the dominent eye. The class was divided into two subclasses; right, in which the eye dominance was dextral and the dominant eye was the *more defective*, and left, in which the eyedness was sinistral

*Submitted for publication July 15, 1935.

in the presence of greater defectiveness of the left eye. Class B comprised all ambi-eyed cases with anisometropia. There were two sub-classes under this heading; right and left, according to which eye had the lower refractive error.

When the dominant eye is the more defective (Group II, Class A) it is probable that anisometropic differences have no conditioning effect on eyedness, but in the ambi-eyed cases (Group II, Class B) there is a possibility that the less defective eye was originally non-dominant, the original dominance being the result of brain factors, and that the lower refractive error of the non-dominant eye exerted a conditioning influence toward a shift in eye dominance, the influence being too slight to bring about a complete change but strong enough to set up rivalry in fixation. It seems probable that in all cases in Group II eye dominance is conditioned by structural and functional conditions in the mid-brain.[1]

Although sixty-four and nine-tenths per cent of the anisometropic cases (Group I) fulfilled the probable requirements for conditioning of eye dominance in the eye with the lower refractive error, the participancy of the mid-brain and cerebral centers can not be ruled out. It is possible that three types of conditioning may occur in Group I.

1. Lower refractive error in one eye may predispose to dominance of that eye, brain factors being quiescent, complementary, or weakly opposed.
2. Refractive and brain factors may predispose to dominance of the same eye.
3. Brain factors may predominate, the lower refractive error of the dominant eye being incidental.

Experience suggests that lower refractive error in one eye, especially when the anisometropia is great, predisposes to dominance of the less defective eye. In my own practice two main types of anisometropic cases, more or less illustrative of this, have been encountered.

1. Eye dominance changes to the other eye when refraction is corrected. It is very probable in these cases that the refractive condition has predisposed to dominance of the better eye.
2. Eye dominance is *opposite* to manual and pedal dominance in persons with *higher* refractive error in the *non-dominant* eye and *lower* refractive error in the *dominant eye*. This offers presumptive evidence of eye dominance conditioning by anisometropia.

When one eye is more nearly perfect than the other its function, presumably, is better and vision should be more acute. Unequal accomodation may compensate for small differences in the refraction of the eyes, especially in low hypermetropia, and to some extent in myopia but at the expense of visual acuity of the better eye. As a result of unequal accommodation visual acuity is often the same in both eyes when the degree of anisometropia is not great. This is one of the reasons why visual acuity can not be used as an indicator of eyedness as was suggested by Woo and Pearson.[2]

It is probable that anisometropia may condition eye dominance in the following ways. When there is a difference in visual acuity the more acute vision of one eye may predispose to dominance of that eye by virtue of the sharper retinal and mental images produced. In cases presenting little or no difference in visual acuity as well as those in which a marked difference is present, the difference in demand on the focusing mechanism may influence eye dominance, the unfavorable stimuli arising from unequal accommodation interfering with the accommodation-convergence relationship and causing unfavorable conditioned reflexes in connection with the muscular control of one eye. When this occurs the disturbance affects the nucleus of the oculomotor nerve which is connected with the nuclei of the abducent and trochlear nerves and with the superior colliculus, in or near which the center of eye dominance is probably located.

It appears that whether eyedness is determined by differences in visual acuity, by unequal accommodation, or both, the determining factor affects the eye dominance center in or near the superior colliculus, either by the connection between this structure and the nucleus of the oculomotor nerve in unequal accommodation, by the connection between the visual portion of the occipital cortex and the superior colliculus, or by a combination of both. There is also the possibility that physical and chemical differences in the retinae may so alter the afferent impulses to the brain that the primary conditioning influence may be an intra ocular one.

Sex differences were examined and this data is presented in Table I. Although the differences in percentage between the two sexes in the totals of Group I and II are the same (22.9%) it is notable that the percentage of males is the greater in Group I, and the percentage of females is the higher in Group II. Throughout Group I the male percentages are greater in every sub-grouping, while in Group II the percentages of females are consistently greater in all classes and sub-classes. This indicates a greater frequency of conditions suggestive of anisometropic determination of eye dominance in males than in females.

The sex differences of both right and left eyed classifications diminish with the frequency of the various forms of eyedness. The greatest difference between the sexes in the sub-classes for right eyed and for left eyed cases is in Group I. In all right eyed subclasses in both groups, the sex differences are greater than in the corresponding sub-classes for left eyed persons, and the smallest sex differences of the right eyed sub-classes is more than twice the largest sex difference for the left eyed sub-classes. This applies to both groups. It appears that there is a greater sex difference in the right eyed groups. The lower percentage of both male and female cases with left eyedness is consistent with the findings of other investigators.[3]

The relation of the better eye to eyedness and handedness was investigated. The cases were distributed in six groupings as follows: A. Cases in which the lower refractive error was in the dominant eye

Table I.

RELATION OF ANISOMETROPIA TO EYEDNESS

Classification, frequencies, and sex differences

Group	% of Aniso. Cases	% of Males	% of Females	Sex Difference	Class	% of Aniso. Cases	% of Males	% of Females	Sex Difference	Sub-Class	% of Aniso. Cases	% of Males	% of Females	Sex Difference
I.	64.9	74.6	51.7	22.9						R	42.3	50.6	31.0	19.6
										L	22.6	24.0	20.6	3.4
II	35.0	25.3	48.2	22.9	A	28.4	22.7	36.1	13.4					
										R	18.9	13.9	25.8	11.9
										L	9.4	8.9	10.3	1.4
					B	6.6	2.5	12.0	9.5					
										R	5.1	1.2	10.3	9.1
										L	1.4	1.2	1.7	0.5

Group I includes all cases in which the refractive error was lower in the dominant eye.
Group II includes all cases of anisometropia not fulfilling the requirements of Group I.
Class A includes cases with the greater refractive error in the dominant eye.
Class B includes all ambi-eyed cases with anisometropia.
R Sub-classes include right eyed cases.
L Sub-classes include left eyed cases.

with manual dominance on the same side as the dominant eye. B. Cases with lower refractive error in the dominant eye with manual dominance on the opposite side from the dominant eye. C. Cases of ambi-eyedness. D. Cases with lower refractive error in the non-dominant eye with manual dominance on the same side as the dominant eye. E. Cases with lower refractive error in the non-dominant eye and manual dominance on the opposite side from the dominant eye, and F. Cases of ambidextrousness. Data for these groupings are presented in Table II. Attention is directed to grouping A in which the percentage of the anisometropic cases is the same as the percentages of each of the sex groupings. The absence of sex difference is notable. The greatest sex differences are in groupings C and E. In grouping C the percentage of females is the larger, while in grouping E th ercentage of males is larger.

Table II.

EYEDNESS, HA. EDNESS, AND ANISOMETROPIA

	% of Group	% of Males	% of Females	Difference
A. Eyedness and Handedness on same side as better eye	40.6	40.6	40.6	0
B. Better eye dominant. Handedness on opposite side	21.8	4.3	18.7	5.6
C. Ambi-eyed cases	6.8	2.7	11.9	9.2
D. Eyedness and Handedness on same side. Better eye is non-dominant	22.5	21.6	23.3	1.7
E. Eyedness on opposite side from Handedness. Better eye is non-dominant	6.8	10.8	1.7	9.1
F. Ambidextrous cases	1.5	0.0	3.4	3.4
G. Handedness and Eyedness on same side (A & D)	63.1	62.2	63.9	1.7
H. Handedness on same side as the better eye (A & E)	47.4	51.4	42.3	9.1
I. Handedness opposite to Eyedness (B & E)	28.6	15.1	20.4	5.3
J. Handedness opposite to better eye (B & D)	44.3	25.9	42.0	16.1

Handedness data was available in one hundred thirty-three of the one hundred thirty-seven cases of anisometropia. The percentage with handedness on the same side as eyedness was 63.1, approaching 2/3 of the total, while the percentage of those with handedness on the same side as the eye with the lower refractive error was 47.4, approaching ½ of the total. This indicates a greater frequency of cases with handedness in agreement with eyedness and probably a closer relationship between the handedness and eyedness than between the eye with the lower refractive error and handedness on the same side. The latter grouping being nearly 50% of the total number of anisometropic cases indicates some relation between the factors of handedness and the eye with the lower refractive error.

The percentage of males displaying handedness on the same side as eyedness was sixty-two and two-tenths, and the percentage of females was sixty-three and nine-tenths. The percentage of males with handedness on the same side as the better eye was fifty-one and four-tenths, while the percentage of females was forty-two and three-tenths. The sex difference in the cases with handedness on the same side as eyedness was one and seven-tenths per cent, while that of the cases with handedness

on the same side as the better eye was nine and one-tenth per cent. There was no great difference in the nearness of either the male or female frequency to the frequency of the entire group; the male being four per cent greater, and the female five per cent less. The conclusion drawn is that there is a tendency toward a higher frequency of males with handedness on the same side as the better eye.

Summary

A group of two hundred ninety cases was examined and one hundred thirty-seven anisometropic cases were found. The relation of anisometropia to eyedness and handedness was studied. Sixty-four and nine-tenths per cent were found to present conditions such as would be expected in the conditioning of eyedness by lower refractive error (or emmetropia) in on eye. The percentage of males was greater than that of the females in this group. Right eyed groupings presented greater sex differences in general. Nearly two-thirds of the cases presented eyedness on the same side as handedness, while the eye with the lower refractive error was on the same side as the dominant hand in nearly half of the cases. The males presented a higher incidence of handedness on the same side as the better eye, while the sex difference in the group with eyedness and handedness on the same side was less than two per cent and of relatively little importance.

Conclusions

1. Eyedness is determined by the conditioning effects of various peripheral and central factors which affect the eye dominance center.
2. Anisometropia is one of the conditioning factors in eyedness.
3. Sex differences are greater among groups of right eyed cases.
4. There is no significant sex difference in the incidence of homonymous eyedness and handedness.
5. The incidence of handedness on the same side as the more perfect eye tends to be greater among males.

References

1. Eames, T. H. The Anatomical Basis of Lateral Dominance Anomalies. American Journal of Orthopsychiatry. Vol. IV, No. 4, Oct. 1934. Pp. 524-528.

2. Woo, T. L., and Pearson, Karl. Dextrality and Sinistrality of Hand and Eye. Biometrika, July, 1927. Pp. 165-199.

3. Selzer, C. A. Lateral Dominance and Visual Fusion. Harvard Monographs in Education. No. 12. Harvard University Press.

DR. THOMAS HARRISON EAMES
31 CHESTER ST.
WEST SOMERVILLE, MASS.

REFRACTIVE WORK AT THE LONDON REFRACTION HOSPITAL*

D. W. A. Mitchell, Lecturer
London Refraction Hospital
London, England

At the outset I want to make clear what the scope of my talk is to be. I was requested by the Council to give an outline of the clinical work at the London Refraction Hospital. It was emphasized that what they wanted was not a theoretical paper, but a discussion of practical points which would interest practising opticians and be useful in their consulting rooms, and it was suggested that I should take as the basis of my talk the routine examination as carried out in the clinic. It will be realized by all of you that it is impossible in the time at my disposal to describe every part in detail; some techniques can only be touched on, and no one part can be treated fully. I shall try to show, however, that this routine, which has been in use for some years, leaves few loopholes for failure in the detection of conditions which may be responsible for discomfort or which may require treatment other than the correction of refractive errors.

A routine examination of the eyes must comply with certain requirements. In the first place, pathological conditions must be detected, if present, so that the patient may be referred to the appropriate quarter. Secondly, the tests must be so chosen that abnormal conditions other than refractive errors may be detected, as these may be a secondary, or even the primary, cause of discomfort. Thirdly, the refractive error must be measured accurately and in older patients, the degree of presbyopia determined. Lastly, the examination must not take up too much time, a consideration which is important to refractionist and patient alike. It is not possible or desirable to include in an ordinary routine examination every type of test. One does not examine every patient with the slit-lamp, and fields and ductions are not always measured. But the examination must include tests which will point to the necessity for further investigation by these methods if and when abnormalities are present.

---

*An abridgement of the material presented before the Institute of Ophthalmic Opticians at the Sixteenth Provincial Conference held at Plymouth, England, June 26, 1935. From the *Refractionist*.

The record card has been designed with a number of objects in view, of which two may be mentioned. A complete record of the examination is essential in hospital practice, so that the exact condition may be ascertained at a subsequent visit. In order that students may acquire the habit of methodical observation, some parts have been amplified.

Section A deals with symptoms and history, B with the examination for pathological conditions, C with field of vision work, D with the estimation of the refractive error and the investigation of the muscles, and E with inferences and the prescription. After wearing the glasses for a month or so the patient reports, and this is recorded in the space at the bottom. Subsequent examinations are recorded on pages three and four.

SYMPTOMS AND HISTORY

It will be noticed that the space devoted to *Section A* is much larger than is generally allowed for symptoms and history in most of the record cards one sees. At the Hospital, this section is regarded as being very important, and students are impressed with the necessity of completing it carefully and thoroughly. Apart from the satisfaction felt by the patient at being allowed to describe his troubles, the refractionist learns many things about the case before examination commences, and receives some indication as to those parts of the examination to which special attention should be given later. The first thing, surely, is to find out why the patient came, whether it was because of ocular discomfort, or bad distance vision, or difficulty with close work, or some general symptoms such as headaches or giddiness which have been attributed to the eyes.

Having ascertained the trouble which prompted the visit, one obtains as much information as possible on the point. One asks how long the symptoms have been experienced. Of particular importance when discomfort is complained of is the association. Is it associated with distance vision, or with continued close work? Is it constant, or at certain periods only? If periodic, at which part of the day is it worst? Is it accompanied by any general symptoms? And so on. The information sought with reference to headaches is shown on the card. The personal history of the patient is inquired into—any previous ocular disease, injury, or abnormality: the state of health, past and present, and if possible, details of any medical treatment received. The conditions under which the patient works, and his personal habits may have a marked influence upon the ocular functions, and it is the duty of the refractionist to advise on these matters when necessary. So much useful information can be obtained that the time required for symptoms and history is well spent.

With reference to the previous correction, one inquires when and for what reason glasses were obtained, and whether they were comfortable and relieved discomfort. It is noted whether they are in the correct position in front of the eyes, or whether the frame is bent—a

frequent cause of discomfort when astigmatic or anisometropic corrections are worn. A knowledge of the power worn previously is most helpful when deciding on any modification necessary in the full correction of the error now disclosed, and may indicate the probable suitability or otherwise of the new prescription.

ABNORMAL AND PATHOLOGICAL CONDITIONS

Section B covers the examination for abnormal and pathological conditions, and a brief description of the points specially considered in this part may be useful.

Position. With reference to position, one notes whether one eye is higher than the other—an important point when strong lenses are required or vertical imbalances found. The presence of exophthalmos or enophthalmos is noted; when monocular these are best detected by looking down from above and behind, with a straight-edge rested on the bridge of the nose. Squints are noted here, and the type recorded (monolateral or alternating, convergent or divergent, etc.). The test used is the cover test. The patient looks at a distant spot-light, and the left eye is then covered. If the right eye does not move to fix, it was fixing before the left eye was covered, or is incapable of fixing. If it does move to fix the light, it was squinting when both were uncovered, and it is then noted whether, when the cover is removed, the eyes turn so that the left may again take up fixation. If they do, the squint is unilateral. If, on the other hand, the right eye maintains fixation after blinking, it is, subject to confirmation, an alternating squint. If no squint is disclosed when the left eye is covered, the test is repeated, covering the right, so as to exclude left eso- or exo-tropia. Finally, the test is repeated with the patient fixing a near object. The eyes must be watched carefully throughout to avoid missing a squint of low degree, a slip which may mean time wasted or wrong conclusions at a later stage.

Movement. The patient is asked to follow the examiner's pencil while it is moved horizontally and diagonally to the limits of the motor field and when approached to within a few inches of the eyes. In this way extra-ocular paralysis, limitation of movement, and weak convergence are detected. A paresis is suggested if the patient sees it doubled at the limits of rotation, and if this is suspected the test is repeated using red and green glasses and the light of the ophthalmoscope. A paresis causes a separation, or an increased separation, when the light is moved in the direction in which the paretic muscle normally turns the eye. Time does not permit of a discussion of the method of isolating the affected muscle. The diplopia is not always noticed in ordinary vision, as it may occur only when the eyes are turned to the extreme limits. The symptoms complained of may resemble those resulting from refractive errors, and since paresis is usually the forerunner of paralysis, it must be carefully excluded. Of course, where diplopia is complained of, the examiner must first determine whether it is monocular or binocular.

The *Tension* is estimated at this stage. This is done by palpation. The index finger of each hand is placed on the closed upper lid, the eyes being turned downwards, and they are alternately pressed, the displacement being noted with the other. Though great accuracy cannot be claimed for this method, it is most useful clinically for detecting raised intra-ocular pressure, and if applied in every case the examiner soon learns the normal "feel" of the eye and is able to detect any appreciable rise. A slight rise is recorded T+1, a great increase T+2, and a stony hardness T+3.

LACHRYMAL APPARATUS AND LIDS

Lachrymal Apparatus. Special care is taken if lachrymation is complained of. One notes first the position of the puncta; a slight ectropion, with a consequent displacement of the punctum, is a common cause of lachrymation in old people. One should look carefully for any swelling over the lachrymal sac—a sign of dacryocystitis, which is a very dangerous condition.

Lids are examined for ectropion and entropion, thickening, the presence of pus, mucoid secretion, or chaff-like flakes among the lashes. If the palpebral aperture is unusually wide and is accompanied by proptosis, other signs of exophthalmic goitre are looked for: (*a*) Dalrymple's sign—palpebral aperture wider than is accounted for by the exophthalmos, (*b*) v. Graefe's sign—when eyes lowered, upper lids lag behind, so that sclera is seen between it and cornea, (*c*) Stellwag's sign—blinking less frequent than normal, and lids do not close completely. The position of the lashes is noted. Trichiasis, and the rarer congenital condition distichiasis, may be the source of great discomfort, and if untreated may result in corneal ulceration.

CONJUNCTIVA AND SCLERA

Conjunctiva. The bulbar and palpebral conjunctivae are examined for follicles, oedema, and injection. If injection is present, it is noted whether it is conjunctival or ciliary. The anterior ciliary veins, which pierce the sclera at a short distance from the limbus, are noted; in chronic glaucoma they may be distended. Any small vascular swelling, especially if situated near the limbus or increasing in size should be referred; it may be a malignant tumour.

Sclera. The sclera is examined at the same time as the conjunctiva. A localized purplish discoloration may indicate scleritis or episcleritis.

CORNEA

Cornea. The cornea requires great care in examination. Slight opacities can easily be missed if they are not looked for methodically, and, though sometimes so difficult to detect, they can cause a marked lowering of vision if situated centrally. Low visual acuity with no apparent ocular cause may be due to amblyopia ex anopsia, or to some serious toxic condition which requires medical attention, and it is the duty of the refrac-

tionist to decide when reference is necessary. If the patient is referred and is told by the surgeon that the eyes are now absolutely healthy, and that the poor vision is due to some cause which was active several years ago, the reputation of the refractionist may suffer. The cornea should therefore be examined carefully by oblique illumination, by transmitted light, and by the slit beam available in some ophthalmoscopes. At the Hospital, if there is doubt as to the transparency of the cornea, the eye is examined by means of the slit-lamp, with which any haziness can be seen under high magnification, and its position in the cornea accurately determined. It may be mentioned here that in the training of students stress is laid upon the importance of distinguishing an active from a passive condition, not only in the cornea, but in any part of the eye. Obviously a case with an old corneal scar which is quite inactive need not be referred. An active ulcer, on the other hand, may be extremely serious, and requires immediate medical attention. The history, the absence of pain, discomfort, and lachrymation, and the freedom from infiltration in the surrounding corneal tissue and hyperaemia in the pericorneal zone will usually distinguish an old opacity from an active ulcer.

Another sign which can easily be missed is the presence of K.P. In severe cases the precipitates assume the typical triangular arrangement described in textbooks, but it is far more common to find only a few minute spots on the posterior surface of the cornea. They may be the only sign of chronic cyclitis, an insidious and painless disease which if untreated may lead to blindness. They may be seen most easily by asking the patient to look up, and examining the lower part of the cornea with the ophthalmoscope and +15 D. against the light reflected through the pupil. If the patterned iris is used as a background they may be missed. In the examination of these spots also the slit-lamp is valuable, but by no means essential.

The slight haziness of the cornea in glaucoma must also be remembered.

Minute abrasions of the cornea can sometimes be painful, and lack of attention may lead to ulceration. They are rendered easily visible by the instillation of one drop of fluorescein solution (fluorescein 2 per cent, sodium bicarbonate 3 per cent in distilled water), the excess being removed with a wisp of cotton wool. The denuded area is stained green.

THE ANTERIOR CHAMBER AND THE IRIS

The Anterior Chamber is examined for depth. A shallow anterior chamber and a small cornea are ideal predisposing conditions for glaucoma.

Iris. The changes occurring in the pattern of the iris and the other signs of iritis are well known. The color of one is compared with that of the other. In the earliest stages of acute iritis there is a change in color due to the hyperaemia. If this is found other signs must be looked for—the size of the pupil in different illuminations and the speed of the reflexes are compared with those of the other eye.

The *Pupil* is examined at the same time as the iris. There are normal variations in size with age, but a marked departure from the average at once arouses suspicion. When an abnormal size is accompanied by an absence or sluggishness of one or more of the reflexes, the condition is definitely pathological—unless, of course, it is due to a mydriatic intentionally or accidentally instilled, a point worth remembering and inquiring into. The examination of the pupil is one of the most important parts of the whole test, because apart from local causes such as iritis, injury or drugs, anomalies are almost invariably due to some serious disease of the visual pathways, nervous connections, or central nervous system. When these anomalies are considered together with defects in the visual field, the site of the lesion can be determined with accuracy. The three most important reflexes are the direct (that resulting when light is shone into the eye under examination), the indirect or consensual (that occurring at the same time in the other eye), and the near reflex (that accompanying accommodation and convergence). The orbicularis reflex (the miosis accompanying closure or attempted closure of the lids) and the psycho-sensory reflex (the mydriasis resulting from psychic disturbances or painful stimulation of a sensory nerve) are sometimes useful in cutting down the probable site of the lesion to within still narrower limits.

The Argyll-Robertson pupil is generally, but not invariably due to syphilis, and there is usually a miosis as well. Great care is therefore necessary in the examination of the reflexes when the pupil is small.

Abnormalities in shape, when not due to operative interference, colobomata, and adhesions, are generally due to tabes.

THE LENS

Lens. The lens is examined by focal illumination, by transmitted light, by the slit beam of the ophthalmoscope, and if necessary, by the slit-lamp. It is necessary to be able to distinguish congenital from other types of cataract, and the position of the opacity (whether nuclear, in the posterior or anterior cortex, or on the capsule) must be known. This may be determined by focussing, by parallax, or more accurately with the slit-lamp. The form and arrangement of the opacity may also give a clue. For future reference the opacity is drawn; when the patient returns for a second examination the condition can be compared with that seen at the first, and any advance noted. In suspicious cases the patient is kept under observation for some time, and if necessary, referred.

Before leaving the lens I would like to draw your attention to a condition the significance of which was first brought to my notice in an article written by one of our Plymouth members, Mr. Stoneman. It is that condition in which, with the retinoscope, radiating shadows are seen which are similar in arrangement to the sector-shaped opacities present in some cases of senile cataract. With the ophthalmoscope no opacities, or only minute punctate ones, are seen, and vision is generally

not affected. They frequently occur in young and apparently robust patients who have not the least suspicion that there is anything wrong. It has been amply confirmed that these shadows are frequently due to some focal infection, particularly in the teeth or gums, though general toxic conditions resulting from diseases like diabetes are sometimes the cause. When the causative factor is removed, the lenticular condition generally clears up, but the importance of their detection probably lies not in the removal of the ocular complication, but in the fact that without attention more serious results may follow. If the teeth obviously need attention, the patient should be referred to a dental surgeon. If the teeth and gums are sound, or if removal of the dental trouble does not result after a short period in the disappearance of the lenticular changes, he should be referred to a general practitioner with a note stating that a focal infection is suspected.

THE VITREOUS

Vitreous. Though from its nature the vitreous can never be the seat of a primary inflammation, it is sometimes affected secondarily by inflammation of the adjacent structures. Abnormalities show as fluidity or opacities. Fluidity cannot be detected in the absence of opacities, but in their presence is diagnosed by their rapid movement when the eye is rotated. Large vitreous opacities may sink to the bottom of the eye, so in the examination the patient is asked to look up, down, and straight ahead quickly, so as to stir them up. Fine dust-like opacities may result from cyclitis, retinitis and choroiditis, and care is sometimes required in their detection. They may generally be seen most easily by careful focussing with the disc as a background, or by observing the pupillary reflex from a distance of one or two feet.

THE RETINA AND CHOROID

The Retina and Choroid should be examined methodically, the various parts in a definite order, so that no area is missed. Perhaps the best method is to examine the disc first, then the macular area, then the vessels and adjacent tissues, asking the patient to look up, down, to the right and to the left, so that the periphery may be seen.

The edge of the disc should be fairly sharp and clear. It is blurred in papillitis and papilloedema, in astigmatism, and in that condition known as pseudo-neuritis met with most commonly in hypermetropic eyes. In astigmatism the different parts can be focussed clearly with suitable lenses and the disc is frequently elliptical in shape. In pseudo-neuritis there are no exudates, haemorrhages, or swelling, and the vessels are normal; if there is any doubt the case is kept under observation.

The color of the disc is noted. Redness alone cannot be taken as a definite sign of hyperaemia, as the normal color varies to such an extent in different individuals, but when one disc is definitely more red than the other it is strongly suggestive of hyperaemia, and other signs must be looked for and the field examined.

The level of its surface is determined by focussing and by parallax. It is not necessary to describe the various types of cupping, or to point out the significance of swelling. It is sometimes stated that a physiological cup does not extend to the margin, whilst pathological cuppings do. This is true in typical cases, but a physiological cup may slope gradually to the margin on the temporal side, and a glaucomatous or an atrophic cup, on the other hand, may not extend to the edge all the way round in the early stages. In doubtful cases, especially when normal acuity is not obtained in the subjective test, the fields are charted.

The macular area is examined carefully in every case. Macular changes generally take the form of a slight mottling, and even when the visible signs are only slight, the degree of reduction in vision is generally considerable.

The vessels receive special attention because of the significance of changes which may be found in them. The blood vessels of the eye are the only ones in the whole body which can be examined directly, in their natural state, without outside interference. It is important to remember, also, that the retinal vessels are structurally similar to the cerebral vessels, and are derived from the same system. It is true we cannot assume that because there are changes in the retinal vessels there are similar changes in the cerebral, but it is just as true that we do not know that the changes in the cerebral vessels are so slight as those in the retinal. It is important that we should recognize the earliest signs of vascular disease in the retina so that the patient may be referred for a determination of the blood pressure and an examination of the urine. What are the earliest signs? The first that may be mentioned is a loss of translucency in the arterial wall, so that a vein crossing underneath cannot be seen through it. Tortuosity of the finer twigs is another sign; the arterioles are always tortuous before the larger arteries. Frequently the only sign is the slight indentation of a vein where it is crossed by an artery; the artery always indents the vein because its walls are thicker, the changes more marked, and the blood pressure in it higher. In some cases an early sign is an uneven calibre; in some places the artery appears narrower than in others. And lastly, one should compare the thickness of the arteries with that of the veins; they should be in the proportion of 2 to 3 or 3 to 4. In some cases of high blood pressure the arteries are narrowed. Admittedly these conditions are not likely to lead to any early trouble in the eyes, but the patients are referred to a general practitioner for the reasons mentioned a moment ago. It is unfortunately true that many cases do not get the treatment they need, but that is the doctor's responsibility. Several investigators have emphasized the significance of these signs, and this is one way in which we can render a valuable service, as the first sign of diseases of the circulatory system may be detected in an examination of the eyes.

FIELD OF VISION

Field of Vision. An examination of the field of vision is essential in the detection of defects in the visual pathways. Indeed, it is the only method by which some diseases can be detected. It is obvious that the examination of the visual functions is not complete when the visual acuity has been determined, as that involves only foveal vision. Fields are therefore examined in all cases in which symptoms and history, or some other part of the test has suggested the possibility of such lesions. They are examined, for instance, (*a*) when vision remains low after correction of the refractive error, (*b*) when the patient complains of a mistiness and vision is found to be normal or only slightly subnormal; (*c*) when the patient complains of persistent headaches or giddiness, especially if these are not removed by correction of the refractive error; (*d*) when the symptoms include flashes of light; (*e*) when there is a "feeling of fullness" or pain in the eye, or any other symptom of glaucoma; (*f*) when accommodation is abnormally low, because a toxic cause may affect the retina and optic nerve also.

The peripheral field is examined with the perimeter. The patient is first made familiar with the test by moving the target inwards along the horizontal meridan on the temporal side and demonstrating the presence of the blind spot. In this way he learns what is required of him, and the accuracy of his replies are tested. The form field is then tested, using a 3 mm. white target. With a target of this size the field should extend to the normal limits, so a larger one should not be used unless vision is low; in detecting slight defects it is necessary to use small targets.

Color fields may be charted with a larger target, say a 5 mm., the patient being instructed to state when he recognizes the color, not when he merely sees it. Frequently before the visual functions are reduced to such an extent that an object cannot be seen, the correct appreciation of colors is interfered with. Color tests are therefore more delicate than tests with white objects. It has been shown that, generally speaking, interference with the outer layers of the retina, the percipient elements (e.g. in early detachment), first produces a loss of blue. Defects in the conducting apparatus and inner layers of the retina (e.g. in tobacco amblyopia) first affect the red and green.

The central and paracentral areas are best examined on the Bjerrum screen. Here again small targets are essential if slight defects are to be detected. One may start by examining the blind spot. A target 3 mm. in diameter is used at 1,000 mm. Seidel demonstrated his scotoma with a target of this size. It must be remembered that the characteristic scotoma in glaucoma is a relative one; it is not absolutely blind, so if a large target is used it may be missed.

The blind spot should be charted when symptoms suggest glaucoma, or when the patient is middle-aged or elderly, the anterior chamber shallow, and the cornea small, especially if hypermetropia is present.

The central and paracentral areas are then examined for scotomata. A 1 or 2 mm. white may be used; with a 1 mm. white at 1,000 mm. the field should extend beyond 30° all around (Traquair says that with a 1 mm. white at 2,000 mm. the field should extend to 26° all round, that is, outside the blind spot). Colored targets are more sensitive. A 5 mm. red may be used if conduction defects are suspected, or a blue of the same size if interference with the outer layers is suggested by other tests. When tobacco amblyopia is suspected, special attention is paid to the centro-coecal area—the area between the fixation point and the blind spot. In this disease, there is loss of appreciation of red in this area before the fixation area is affected, and even in the later stages the scotoma is always denser between the blind spot and the fixation point than at the fixation point itself, and that for red is much larger than that for white.

The presence of an absolute central scotoma renders fixation of a small object difficult or impossible, so the defect cannot be investigated in the ordinary way. In these cases the Fincham fixation device is used The good eye views a series of circles and squares reflected from a mirror, and the affected eye a similar series on the Bjerrum screen. They are fused, and a stereoscopic effect is obtained, which keeps fixation steady. The value of this instrument is not confined to cases of central scotoma. It enables a more steady fixation to be maintained in all cases.

In all field work the size and distance of the target are recorded. Unless this is done it is impossible for others to draw any conclusions from the chart, because, of course, the field varies with different sizes. Also, it is necessary to be able to repeat the test under similar conditions if the patient is to be kept under observation.

RETINOSCOPY

Retinoscopy is done in every case, and in the training of students emphasis is laid on the importance of getting accurate results every time. If one is satisfied with approximate findings in the majority of cases, half of the value is lost, and it is impossible to obtain reliable results in the comparatively few cases in which subjective testing is out of the question and everything depends upon retinoscopy. Those who do it regularly do not need to be reminded of the advantages. A great deal of time is saved in the subjective test, and in most cases it is only necessary at this later stage in the examination to make a few fine adjustments, such as checking the axis and power of the cylinder and deciding on any modification of the sphere necessary to give best vision. This alone is a weighty consideration, since few parts of the examination require so much of the patient and lead to fatigue more quickly than the subjective test. Retinoscopy sometimes discloses latent errors which would pass unsuspected if reliance were placed solely on subjective results. Further, the first indications of some abnormal conditions, such as conical cornea, corneal facets, and lenticular irregularities may be obtained during retinoscopy.

There are one or two technical points which, though not new, may be worth mentioning, as they are frequently overlooked. I suppose one of the first things students are told when learning retinoscopy is that they must work as close to the visual axis as possible, yet it is not rare to see someone working 15° to 20° off. The second point concerns what is perhaps the commonest cause of inaccuracies, apart from actual carelessness—neglect of the principle that attention should be confined to the center of the pupil. The lens produces spherical aberration, which may be positive or negative, more frequently the former. In the dim illumination in which retinoscopy is done the pupil is dilated, and parts of the lens are exposed which are not used in ordinary vision. These peripheral parts must be ignored and lenses added until the movement in the *central* area is neutralized.

In hypermetropic cases one frequently finds that accommodation relaxes gradually while retinoscopy is being done. After correcting the second eye one should return to the first and note whether more plus sphere can now be added. By passing from one eye to the other in this manner a part of the latent error can often be uncovered. In cases of this type the relaxation may be hastened by placing in front of the eye not being refracted base-in prism of a power just within the limits of abduction, the inhibition of the medial recti tending to induce an accompanying inhibition of the ciliary muscles.

One need not say much about the *Subjective Test*. For obvious reasons it must be made as short as possible, and a careful retinoscopic test is of great assistance in achieving this end. One does not suggest, however, that the subjective should be done hurriedly. On the contrary, the patient should be given time to make his decisions carefully. He realizes that this part of the examination depends upon him, that the result rests upon his judgments, and he is apt to feel dissatisfied later if there is any suspicion of rushing.

Time given to check tests is well spent. The few minutes employed in making the final fine adjustments may mean the difference between partial and complete relief, between making the patient a constant advertisement for one's services and losing him altogether.

AMPLITUDE OF ACCOMMODATION

The measurement of the *Amplitude of Accommodation* is never omitted. A low amplitude may indicate a pathological condition such as glaucoma or cyclitis, but perhaps the commonest cause is a focal infection, and of these apical infections of the teeth are apparently the most frequent source of trouble. When, therefore, the amplitude is low for the age, and there is no obvious local cause such as myopia, one should suspect some abnormality, and if a pathological origin cannot be ruled out, the case should be referred to a doctor or a dentist. It is worth noting that the amplitude is frequently reduced after debilitating diseases such as influenza; in these cases it returns to normal in a few weeks.

There is a second reason why the amplitude of accommodation is important. It is unsafe to prescribe a reading addition without a knowledge of the reserves, as one is then working in the dark. A few weeks ago I examined a person aged sixty-two with an amplitude of 6 D. She would certainly have been uncomfortable if I had prescribed a reading addition of from 2 to 2.5 D., as is usually required at that age.

The *addition for near work* is decided on only after a number of factors have been taken into consideration. Among these are the amplitude of accommodation, the use to which the glasses are to be put and the distance at which close work is done, the near muscle balance, the strength and suitability or otherwise of any previous correction, and so on. It is wise to acquaint the patient with the limitations of reading glasses if he has not worn them previously; to omit this and let him discover the disadvantages himself may result in disappointment.

MUSCLE BALANCE

Muscle Balance. Many practitioners do not investigate the condition of the muscles. Its importance need hardly be emphasized here. When the eyes are used in vision, they have not only to see clearly, but singly also. In other words, not only must the refraction be accurate and the ciliary muscle functioning comfortably, but the extra-ocular muscles must work in harmony also. Discomfort is almost as likely to be due to strain resulting from a muscle imbalance as to an error in refraction. No examination of the eyes can therefore be complete without muscle tests.

It will be noticed that on the Hospital card three spaces are provided for the recording of the muscle balances: (1) without lenses, (2) with the old prescription, and (3) with the new prescription. If a person has not worn glasses before, the balance is taken before the subjective test and recorded in the first space. If he has worn them constantly, the balance is recorded in the second. If the old correction has not been worn constantly, it may be thought advisable to complete both (1) and (2). After the subjective test the muscle balance is measured with the new correction, and recorded in (3). The great advantage of taking the balance without and with the new correction is that it is possible to note the effect of the new correction. If the new lenses lessen esophoria or do not increase exophoria unduly, they are likely to be comfortable. On the other hand, if esophoria is increased, or a low exophoria changed to a high one, discomfort is probable, and it may be wise to modify the new prescription.

The method of taking muscle balances has been under discussion at the Hospital. It is well known that with different methods different results are obtained. This may lead to wrong conclusions if another refractionist using a different method obtains a different result at a later date. In a hospital it is therefore necessary to adopt some routine method, and it may interest you to know what methods are being investigated with a view to adoption in the clinic.

The Maddox rod is to be used for the distance tests, both horizontal and vertical. There is probably no better test for the distance vertical. Advantages for the prism displacement method for the determination of the horizontal balance are claimed by some. Without entering into a theoretical discussion on the merits and demerits of these two methods, suffice it to say that for practical reasons it has been decided to use the Maddox rod. The patient must look at the light, not at the red streak.

To determine the horizontal balance at the near point a simple instrument is used. In the cells in front of the eyes are two prisms, each 5 △, base-up, before the right eye and base-down before the left. These cause doubling of a horizontal line on a card placed 40 cm. from the eyes, at the other end of the rod. The horizontal line has divisions indicating prism diopters, and in the middle is a vertical arrow. When the line is viewed through the prisms, the eyes are dissociated and assume the position determined by the muscle balance, and the patient has merely to state the division on the upper line to which the lower arrow points. The letters or figures by which the divisions are marked are small enough to ensure accurate focussing by the patient.

The disadvantage of the Maddox rod and a light for the near horizontal is that there is no incentive to accurate foeussing, so the result obtained may not represent the true condition when the eyes are doing ordinary close work at the distance of the test. The Maddox rod generally shows more exo. than is actually present at the reading distance.

The near horizontal balance is very important, and a great deal of information can be obtained from it. In the first place, it informs us of the state of the muscles in near vision, an important point in modern life when so much close work is done. In the second place, by comparing it with the distance imbalance we can obtain figures which tell us something of the relationship between accommodation and convergence.

To determine the vertical balance at the near point another instrument is used. A card is placed at 40 cm. and the right and left halves are hidden from the opposite eye by a septum. On one side is placed a horizontal line, and on the other a vertical line divided to represent prism diopters. The patient states through which division the horizontal line passes.

The same instrument is used to test for suppression and stereoscopic vision. Attached to the head of the instrument are a pair of 10 △ prisms, base-out. These are placed in position and a card is viewed by which these are detected.

The advantages of these instruments are that they are simple and strong, and cannot be put out of adjustment easily. Further, they are quick and reliable. All these are important considerations in hospital practice.

It is hardly necessary to point out that the correcting lenses must be accurately centered in muscle balance tests. This is particularly neces-

sary in anismetropic cases when the vertical imbalances are being measured, as low vertical errors generally have a greater significance than horizontal ones of the same degree.

DUCTIONS

Ductions. When the imbalances have been determined, we may want to know what reserves there are to cope with them. Someone has called the ductions assets and the imbalances liabilities. If the ductions are not known, it is impossible to decide whether a certain imbalance will cause discomfort or not. An imbalance which would cause discomfort if the ductions were low may not give rise to any difficulty if the fusional reserves are high. On the other hand, a *low* imbalance may upset the binocular functions if there are no reserves in the form of ductions. The relationship between a muscle imbalance and the duction which looks after it is similar to that between the accommodation exerted in near vision and the amplitude; a youth with a high amplitude and a good reserve has no difficulty in exerting 2.5 D. for reading, but in early presbyopia, when the person has an amplitude of say 4 D., the exertion of 2.5 D. produces discomfort because the reserves are low. Imbalances and ductions have to be considered in a similar way. When the imbalances have been measured, we determine what reserves are available to cope with them. It is generally held that there must be a reserve equal to twice the imbalance overcome; in other words, only one-third of the total duction power can be used constantly with comfort. Ductions are therefore of special interest when the prescription does not relieve the symptoms.

Abductions should be measured before adductions. Abduction is a relaxation of the medical recti, and is less likely to upset the existing relationships than adduction, which is an active, effort-requiring process. It is not uncommon to find abduction low for some little time after an adduction test.

Prisms should be turned up fairly quickly in the first measurement, the reading obtained not being recorded; it gives some idea of the measurement to be expected in this particular case, tends to overcome the effects of a previous measurement in the opposite direction, and acquaints the patient with the nature of the test. Then the measurement is repeated, prism being added slowly. A third reading may sometimes be taken with advantage, and the higher of the two recorded.

In the measurement of the distance horizontal duction, the patient views a small letter at 6 meters. For abduction, base-in prism is rotated until the letter doubles. This is recorded as the break. The prism is then reduced until the letter is single again. There is often no blur point in distance abduction. For adduction, base-out prism is rotated until the letter blurs, and this is recorded as the blur point; this gives the positive relative convergence, the amount of convergence which can be exerted without accommodation coming into play. The prism is increased until

the letter doubles (the break) and then reduced again to the recovery point.

Some practitioners use a large object, such as a 6/60 letter, for distance ductions. With this the blur point is not so definite. Others use a spot light. The same difficulty is encountered here, and in addition, there does not seem to be sufficient incentive to "hold" it, and the readings are rather lower.

For the near horizontal ductions a vertical row of letters is used, the plur point, break, and recovery being noted as before. In this test, care must be taken to see that the patient is not suppressing the image of one eye, or confusing and misleading results will be obtained. The patient is asked to state if the vertical line begins to move to the right or left, an indication that it is being seen with one eye only. On the other hand, a statement that the letters seem to be getting smaller or larger is an indication that both eyes are seeing and that there is fusion. Although suppression must be remembered in all duction tests, I mention it here because it is commonest when there is high exo. for near.

Vertical ductions are measured by means of loose prisms or a low-power rotary prism. Because the vertical ductions are normally so low (3 to 4 △) vertical phorias assume a special importance, and even low degrees require careful consideration. Before prescribing a vertical prism, one should be satisfied that the phoria is present when the eyes are turned up and down, and that it does not disappear after wearing for some time suitable lenses for the correction of the refractive error.

Here it may be well to draw attention to the work which is being done on the subject of ciliary imbalance as a cause of ocular discomfort, and the significance of a low vertical error as an indication of this condition. Some workers hold that it is impossible for one ciliary muscle to be innervated more than the other to an extent greater than about 0.25 D. Others contend (and there is a great deal of clinical evidence to support this view) that in anisometropic eyes monocular latency can be developed in the course of adaptation to an abnormal condition. The limits set by the performances of a *normal* pair of eyes cannot be regarded as binding when abnormality has been present from birth or for many years. Thus in a vertically orthophoric pair of eyes we consider that the usual limit of hyperduction is under 5△. Yet how often do we find higher degrees of hyperphoria being overcome, binocular vision obtained, and, amazing though it may seem, no discomfort arising. There seems no reason why an unequal innervation of the ciliary muscles should not be developed in the same way.

The appearance of a low vertical imbalance in such cases may possibly be explained by the fact that four of the extra-ocular muscles are supplied by branches of the same nerve as that which innervates the ciliary muscles—the third cranial or oculomoter, and that in these cases they are over-innervated. The superior and inferior recti cancel each other vertically, and the abduction of the inferior oblique is cancelled by the

adduction of the medial and vertical recti. The only actions left over are the elevation and torsional effects of the inferior oblique. If this explanation is correct, one would expect to find cyclophoria as well as hyperphoria. The correct treatment in these cases is to uncover and correct the latency, not to prescribe vertical prism: the Esdaile-Turville Equilibrium Test has been devised for this purpose.

In measuring ductions, special attention is given to those which have to overcome the imbalance found; in exophoria, for instance, it is the adduction which is most important. The value of obtaining a knowledge of the reserves is not confined to cases where there is an abnormal muscle balance, however. Frequently cases are seen in which low ductions are found with normal muscle balances. Such a combination may indicate a condition of strain in the other ocular functions, or a lack of sustained effort due, perhaps, to a lowering of the general reserves of nervous energy. Medical attention, or a rest, will often accomplish a great deal in these cases.

One word about exophoria before we leave this subject of muscle balances and ductions. It is generally agreed that the most desirable condition is a low degree of exophoria in the distance test, and that a physiological exophoria not exceeding about 6 $\triangle$ in near vision is normal. We occasionally examine young people with a higher degree of exophoria. In these cases, although the reserves may be adequate and there is no discomfort, it is wise to prescribe exercises to reduce the imbalance while the patient is still young enough to benefit from them. Exophoria tends to increase with age, and it may reach a degree beyond that which can be comfortably overcome. Further, after a certain age, which may be taken as between forty-five and fifty, no permanent benefit is derived from exercises, and it is necessary to resort to prisms. We therefore take steps to reduce the exophoria and build up the reserves while it is still possible. Adduction exercises may be given in a number of ways, but one method which is efficient and which is convenient for continued application because no apparatus and little time are required is the well-known pencil to nose exercise.

REFRACTION OF CHILDREN

I would like to say a few words about the refraction of children. Some opticians do not refract children, but refer them to ophthalmic surgeons, which may suggest to parents that medical men are superior to us in refractive work and contradicts our contention that in this field the qualified optician is supreme. Further, these children will probably continue to consult ophthalmic surgeons when they grow up. There is no reason why children should be sent to them. In the first place, a cycloplegic is not always essential, as there are other means at our disposal for inducing relaxation of accommodation; and in the second place, there is no law in this country preventing an optician from using drugs when they are necessary.

At the Hospital, so much importance is attached to the refraction of children that one afternoon per week is reserved for them. Students attending then not only become familiar with this work, but acquire the art of dealing with children in such a way as to avoid arousing in their young minds fears and antagonisms which are fatal to a successful examination.

With very young children a subjective test is impossible, and reliance has to be placed on retinoscopy. Difficulty may be experienced in getting the child to fix some distant object steadily; his eyes almost involuntarily turn to the light flashing from the mirror, so the pupils contract, accommodation is exerted, and retinoscopy is rendered extremely difficult. When atropine is used, however, it does not matter if the child does look at the light—in fact, he is encouraged to do so, as the refractionist is then certain that he is looking along the visual axis. The pupil is dilated and the accommodation is at rest, so retinoscopy is rendered comparatively easy. Because of the wide dilation of the pupil, one must be particularly careful to confine one's attention to the center of the pupil. And because the normal tonus of the ciliary muscle is temporarily abolished by the cycloplegic, one must deduct about + 1 D. (or add about — 1 D.) from the finding, in addition to the deduction for the distance of the observer from the patient. The exact amount varies with the case, and several factors have to be taken into consideration. In myopic cases it is found that less than — 1 D. must be added. In those hypermetropic cases in which a full or fairly full correction has been worn previously, the deduction would be about 1 D. If no correction has been worn, and a high or fairly high degree of hypermetropia is found, more than 1 D. would be deducted, as a full correction is unnecessary in these young patients, and indeed would be uncomfortable. These considerations are of course modified by other factors such as muscle balance; if high esophoria is found, or a squint is present, a full plus correction would be prescribed in hypermetropic cases whether glasses had been worn previously or not. The deduction therefore depends upon the type and degree of error, the condition of the muscles, the degree of discomfort complained of, the strength of any previous correction, and the proportion of latent to manifest error as shown by a comparison between that revealed under cycloplegia and that found in a pre- or post-cycloplegic test. One of the arguments sometimes brought against the use of atropine is that the deduction is arbitrary, but it must be agreed that these same factors have to be taken into consideraion when any prescription is written, and just as experience teaches one what modifications are advisable in ordinary cases, so one soon learns what deduction is necessary when a cycloplegic has been used.

At the first visit, as many details as possible are obtained; retinoscopy is done, and if the child is old enough a subjective test is carried out and the muscle balance investigated. If necessary, atropine ointment is given, and the parent instructed to place a small portion inside the

lower lid twice a day for three days prior to the examination on the following Wednesday. No ointment is used on the day of the examination, as it makes the cornea greasy and interferes with retinoscopy. When the *total* error is known, the proportion thought necessary is prescribed.

If there is a latent error, and, for some reason, a full correction is prescribed, the use of the ointment is continued until the glasses are obtained so as to render their immediate use more acceptable and easy. In squint cases, steps are immediately taken to prevent the development of the amblyopia which will quickly follow in all but alternating cases, and which is much more easily prevented than cured. If amblyopia is already present, treatment for its removal is prescribed. The name is placed on the list of squint patients awaiting training, and the child passes into the care of the Squint Training Department.

SQUINT DEPARTMENT

The work of the Squint Department was the subject of an article in a recent issue of the *British Journal of Physiological Optics*. Time does not permit of a description now. No talk on the activities of the Hospital would be complete, however, without some reference to it. Only those who have had experience in squint training realize what endless patience and unquenchable enthusiasm is required for this work, and one cannot but admire those men who for years have not only attended the clinic every week, but have given thousands of their leisure hours to the study and elaboration of the techniques employed in the non-surgical treatment of squint. The results obtained in a large and increasing number of cases is proof of the success of their efforts, and the fact that some instruments which have recently been hailed in some quarters as new and marvelous have been in use in the Hospital for a number of years indicates that these men are leaders in this difficult but important branch of ophthalmology.

DRUGS

Before closing I want to say a few words about the use of drugs. I am well aware of the controversy which has centered round this subject, and of the arguments used by those who prefer to do without them. It is the contention of many, however, that while the proportion of cases requiring them is very small, they can, in these few cases, be of great assistance. There is not sufficient time now to enter into a discussion on the subject. Suffice it to say that the authorities consider that students passing through the Hospital should at least know how to use them, should be able to select those cases in which they may be expected to prove useful, and be aware of any possible dangers which might attend their indiscriminate use. One used to hear a great deal about the dangers of using drugs. It can be said at once that there is not the slightest danger if the refractionist knows what drugs to use, how to use them, and the conditions in which they are contra-indicated.

At the Hospital the drugs most commonly used are Atropine, Homatropine, Euphthalmine, and Eserine.

Atropine is used as a cycloplegic for children, in the manner described earlier. It is never used as a mydriatic for elderly people, because the prolonged mydriasis cannot be overcome by a miotic, and there is a possibility of producing glaucoma if other predisposing conditions are present.

Homatropine Hydrobromide, in 2 per cent solution or in the form of tablets containing 1/40 gr., is used as a cycloplegic for young adults who would be inconvenienced by the week or so of cycloplegic produced by atropine. With Homatropine accommodation returns to normal in something over twenty-four hours. Three drops are instilled with an interval of twenty minutes between each, and after the last instillation one waits for half an hour or until the amplitude is reduced sufficiently.

Homatropine Hydrobromide in ½ per cent solution, or in the form of tablets containing 1/400 gr., and Euphthalmine in 1/40 gr. tablets, are used as mydriatics, and are safe even with elderly people, as their effects can be overcome almost immediately if necessary with Eserine. One drop or one tablet is sufficient, and the pupil is well dilated in about twenty minutes. After the examination Eserine is instilled.

Eserine is used as a miotic, either as a 1 per cent solution in oil, or as tablets containing 1/600 gr. of the sulphate.

I stated just now that it would be impossible to describe in detail the various parts of the examination. I am aware that some techniques have not received all the attention they deserve, but I hope that most of you have been able to glean a few interesting and useful points from my talk, and if your eye-examinations are in some small way made even more efficient and thorough, your attendance here this afternoon will have been worth while.

THE DISCUSSION

Mr. Slade Lawrence said that in referring to differential ciliary innervation, the lecturer catalogued the actions of the muscles and said that the recti cancelled one another out. He said that the action of the inferior oblique was cancelled by the internal rectus. Should that not have been the superior oblique?

The lecturer said there were four extra-ocular muscles innervated by the third nerve—the superior, inferior, and medial recti, and the inferior oblique. Vertically the superior and inferior recti cancelled each other, but the vertical action of the inferior oblique was not opposed.

Mr. Slade Lawrence asked what happened to the superior oblique.

The lecturer said it was innervated by the fourth cranial, and did not enter into this consideration. He pointed out that he was merely suggesting a possible cause for the appearance of hyperphoria in a case of ciliary imbalance due to unequal third nerve innervation.

Mr. Dupont said that when taking ductions, the lecturer suggested using a small letter. Would he take the 6/6 letter?

Mr. Mitchell said he would take about 6/9, or almost the smallest line seen by the patient. They had letters of different sizes on the Institute chart. The chart was closed and a small letter hung on the front. The blur point was rendered quite sharp in that way.

Mr. Cox asked whether he regarded the blur point as more important than the break.

Mr. Mitchell said because they did not know what these things meant it was difficult to say which was more important, but although it was quite common practice to take the break as the duction measure, there were many people who thought the blur point was the more important. Assume that they had an exophoria for distance. It was a distance imbalance, and they wanted to find the distance reserve—in other words, they wanted to know how much convergence could be exerted with the accommodation adjusted for distance. This was shown by the blur point. Any convergence which could be exerted beyond that, but which entailed an increase in the amount of accommodation, so that it was no longer adjusted for infinity, could hardly be considered available as a reserve for a distance imbalance. Many writers had tried to explain what the break and recovery points meant, but he thought that it must be admitted that their full significance was not yet known.

They could only work from practical experience. They knew that if they could rotate, before reaching the blur point, prisms equal to twice the imbalance, the person would probably be comfortable. If it was reached before that amount was rotated, experience showed discomfort was probable. He would say that the blur was more important than the break.

Mr. Dupont said there was a confusion of terms in the text-books.

Mr. Mitchell said it was about time that these terms were standardized. He did not know if they had read Sheard's article in the *American Journal of Optometry*. He said that duction was the same as fusional reserve. That may be true if duction meant the amount of convergence which can be exerted from the parallel position. But some regarded the duction as including that required to bring the eyes from the physiological position of rest to the parallel position. Take a case with a distance exophoria of 3 △ and a blur point at 12 △ base out. Some regarded the duction as 12 △, others as 15 △. If the latter was correct, duction was not the same as fusional *reserve*. It was time they had some standardization of terms used in muscle work. The last bit of work in that way was the standardization of methods in taking muscle imbalance and when it was started it was intended to follow it up with the standardization of the methods used in taking ductions. It was not completed yet, but probably when it was this would be considered.

A BASIC TECHNIQUE IN ORTHOPTICS*

PART TWO

William Smith, Opt.D.
Roxbury, Mass.

In a recent article of similar title which appeared in the June issue of THE AMERICAN JOURNAL OF OPTOMETRY I discussed at length the training of amblyopia-ex-anopsia and touched rather lightly on the second part of the work, namely, training of fusion, and coordination. While there is mention made of a modus operandi for that second part of the training, no actual demonstrative case is given. This, of course, was done on purpose, as I felt that the problem of amblyopia is in itself a problem which merits discussion and the development of amblyopic eyes, being an integral part of orthoptics—that phase alone was to be considered. Fusion training and the actual correction of strabismus and heterophorias which constitute the second part mentioned, will be discussed rather broadly in this article and cases cited to demonstrate results.

A case which I discharged recently as fully corrected is that of a young girl now nine years old and who came to me professionally at the age of five. This was in June, 1930. She had been to a hospital and was prescribed under atropine:

O.D. +3.00 D.Sph.⊂+2.00 D.Cyl. Axis 90—V.A.?
O.S. +3.00 D.Sph.⊂+2.00 D.Cyl. Axis 180—V.A.?

The girl had a right convergent strabismus which came as a result of scarlet fever two or three years previously. The child appeared physically underdeveloped. She was underweight, and rather small for her age. A complete examination of the girl's eyes disclosed no astigmatism but a high amount of hyperopia. The child didn't cooperate during the skiametry tests and I marked down the dynamic findings as the only ones reliable. Statically and dynamically she neutralized O.D.+6.50 D.Sph.
O.S.+6.00 D.Sph.

There was no indication of pathology and the reflexes to light and accommodation were negative. I prescribed subjectively +4.00 D.Sphere O.U. which gave her, on the children's chart, 20/30-? Both eyes appeared orthophoric at times and so I advised the occlusion of the left eye for stated periods and also advised orthoptic training which the mother

*Submitted for publication April 16, 1935.

promised to consider. I was to keep watch over the child's eyes and to check them monthly. A month after the examination the two eyes appeared straight for long periods at a time with and without correction. The visual acuity did not improve, however. In August of the following year the girl came back with her mother and decided to start on orthoptics. She had an attack of German Measles during the past month and the right eye turned in again with and without glasses.

I re-examined the girl's eyes and prescribed O.U.+5.00 D.Sphere with an +1.50 D.Sph. addition O.U. in Kryptok, for constant wear. This was given her with the object of bringing out the latent error, and also to relieve the over exerted ciliary muscles. I started training the apparent amblyopia. The girl having entered school, was at this time somewhat more responsive. Macular fixation training was part of the amblyopia exercise. I accomplished this by having her draw circles around small letters; by having her color in cut-out pictures from the comic strips and by improvising other means, such as rolling marbles along a narrow band, by picking out and tracing letters on the Jaeger chart and by using the telebinocular on which she traced pictures and then colored them. I tried to vary the program as much as possible and I also tried to make it as interesting as possible. My object was to keep the child's interest and cooperation. When the visual acuity was raised sufficiently, I put the girl on the Wells Phorometer and commenced training coordination and fusion. I gave her both, base-in and base-out exercises and she was getting along splendidly. The eyes became orthophoric, both with and without correction and remained so for most of the day. The girl began to show an aptitude for fusion. Then suddenly and without warning, the girl stopped coming for her appointments and more than three months passed until her mother thought of informing me that the child had an attack of diphtheria, and wanted to know if and when she could resume treatments.

In July, 1933, after a lapse of over six months, the girl came again. This time the complaint was that the right eye hurt and that there was occasional headache over it. The right eye turned in only when the girl was tired or didn't wear the glasses. There were times, however, when both eyes were straight even without correction.

I re-examined the girl's eyes and prescribed the same correction as she had formerly worn, but in single vision lenses. The +5.00 D.Sph. O.U. gave her 20/20-vision in each eye and the same acuity with the two. We resumed training, this time on the Telebinocular using the Duction slides and producing base-in and base-out effect by moving the slides away from and toward each other, respectively. The amplitude of fusion kept increasing and the girl reported stereoscopic vision. The eyes remained orthophoric for weeks at a time. She was definitely on the road to amelioration when an attack of whooping cough interrupted the training once more.

In June, 1934 she returned again, but there were no visible external signs of squint. Examination of the eyes required changing the left lens only and then only a quarter of a diopter. I gave her O.S. +5.25 D. Sphere and the visual acuity was still 20/20- O.U. Fusion was apparent, although weak and there was a semblance of a feeling for stereopsis. I exercised her eyes by the method started in July, 1933 and continued it three times a week for three months. Financial reverses made it impossible for the girl to continue the training and I advised her mother how to continue it at home, which she did for only a short period. I re-examined the girl in May, 1935 and was amazed at the change which had occured. Her eyes are orthophoric at all times. She has good fusion faculty. She has binocular perception. Stereopsis is good and the visual acuity is 20/20 in each eye with +4.50 D. Sphere O.U.

I mention this case as an illustration of the contention that perseverance is an essential factor in the training of strabismus. The educative process upon which the modern technique in orthoptics is based, created new pathways in the brain which can not be erased and which are not easily forgotten. The setbacks which occured as a result of the various febrile attacks in no way marred the new visual habits learned during the periods devoted to this educative process and the only thing that might have eradicated them would be perhaps damage to these pathways.

In all cases of muscle imbalance whether heterophoria or heterotropia my first step following the case analysis is to map out a program of training to which I adhere tenaciously. Experience has taught me that such a method is productive of most results. While I may vary my treatments or the media with which these are administered, my program is usually followed to the letter and nearly always in sequence of its arrangement. The case described above was carried out in such a manner and the case which will follow is being carried out at the time this article is being written, in a like manner.

C. D. R., 12 years old and a public school student, was examined at a hospital and prescribed:

O.D.+1.50 D.Sph.⌒+0.25 D.Cyl. Axis 90—20/50 V.A.
O.S.+1.00 D.Sph.⌒+0.37 D.Cyl. Axis 90—20/30 V.A.

The boy has been showing signs of nervous irritation and has been under care of a nerve specialist. There were the usual symptoms of asthenopia and the right eye had a convergent strabismus of about 20° without correction and of about 10° with it. The fundi were normal, so were the media, pupillary reactions and the rotations and versions. My examination revealed the following prescription:

O.D.+2.25 D.Sph.⌒+0.75 D.Cyl. Axis 90—20/30-
O.S.+2.25 D.Sph.⌒+0.50 D.Cyl. Axis 90—20/20 -

The eyes appear orthophoric with this correction, but there is no fusion, either macular or perimacular and no stereopsis. He shows a right suppression.

The program to be followed for a successful conclusion of this case had to be mapped out with understanding and precision. In the first place I had to eliminate the right amblyopia and then correct the suppression in the right eye. After all this was accomplished, the next step was to coordinate the function of the two eyes by developing fusion. When that was attained, the faculty of stereopsis had to be developed.

With this in mind I outlined a program of training. I used the Keystone Telebinocular apparatus in this case, as I could accomplish two tasks at the same treatment—visual acuity and fusion as well as duction and fusion, the cards being so made that the fusion element must be stimulated to obtain coordinate action. The program follows:

1. Correct-eye-scope tracing. (The picture to face alternatingly the right and left eye.)
2. Amblyopic training on Telebinocular (using the V.A. cards).
3. Suppression training (using suppression slides, both right and alternate).
4. Near point work and macular fixation of right eye (using newsprint for reading and circling).
5. Fusion training (using duction slides, both induced and shock and the stepping stone series—color plates).
6. Stereometric and stereoscopic slides.

SUPPLEMENTARY TRAINING:

1. Put left eye to work also (briefer periods).
2. Retinal stimulation by flashing light in right eye.

I started training on March 28, 1935. At first progress was rather slow. It seems that the boy's mind rebelled at the new procedure to which it was being subjected, but after a while the boy overcame all difficulties and I am contemplating discharging him as fully corrected by the middle of June, 1935. His visual acuity is 20/20 plus in each eye. He has excellent fusion and 105% of stereopsis. His mother reported that all his signs of nervousness have disappeared and that the boy is winning back all the marbles he has lost in the past eight years, since the squint has become apparent.

The program of training was carried out in the sequence outlined. There were, of course, some variations, but these were made to give the treatment a semblance of variety and thus to obviate the possibility of monotony and the likelihood of memorizing. Yet the variations were not deviations from the plan but were merely varying phases in the original plan and were adapted for the particular makeup of the patient.

An important factor to remember in the training of orthoptic cases is consideration of the age, physical and mental makeup of the individual patient. Routine must be adapted for the particular patient's mental age and intelligence. The entire procedure must be turned into a sort of a game when the patient is a young child and each adaptation or change in

routine must be made so that it would appear as a new game each time. Knowledge of child psychology is an essential factor in the successful handling of orthoptic as well as ordinary refractive cases when dealing with child patients. No amount of imploring, promises or threats will be of as much avail as will be the anticipation of a new game or a star or a colored piece of paper with a picture of "Popeye the Sailor" on it. I found that the orthoptic patient regardless of age will put more effort and try to do better work when I pass favorably on his accomplishment during the visit. I always try to create a desire to "beat the score" on part of the patient and encouragement and occasional praise is of great help. Criticism, if unfavorable, reacts on the patient's mental attitude and frequently retards progress.

A case on which I am now working is typical of the foregoing. The patient is a young girl 15 years old and has amblyopia in the right eye due to a convergent strabismus which became straight when glasses were put on. I do not recall her optical prescription and I do not believe that its recording would materially affect the point. Suffice it to be said that it is a strong compound hyperopic astigmatism prescription and it corrects the right eye only 20/100– and the left eye, 20/20.

As is my accustomed routine, I planned the girl's case and arranged a program of training. But it seemed that my assistants could make no headway with the case. There was some improvement made when I first took the case, but there it ended. My assistants presented the problem during an orthoptic staff conference and I decided to handle the case on its next visit.

In looking through the records of this case, I noticed recorded that the girl "was not co-operative." It was explained to me, upon inquiry, that the girl doesn't do as instructed. She shows signs of laziness, and she shows preference to some work and shirks other. This truly was a case that called for deep study and concentration.

I saw the girl during the visit and casually made inquiries as to the progress she was making and asked for suggestions. I watched the assistant give exercise and discovered the cause for the complaints. Heretofore our patients have been children of six, seven, eight or nine years of age, and the routine, while identical with the one mapped out for the 15 year old girl, was adapted in each case to conform with the mental age of the patient. Apparently the girl felt herself as being above the category of a child and expected us to treat her as an adult, and in order to show her resentment she retaliated by being uncooperative. This was remedied and the results were nothing short of amazing.

One of my orthoptic cases is a youth of 18, of better than the average intelligence and who has aspirations to enter the Naval Academy. In preparation for this, the young man has been taking various physical tests and has consulted me concerning his eyes. He never had glasses.

A compelte examination of his eyes revealed the following data:

Visual Acuity: O.D. 20–20—3

O.S. 20/20

Uncorrected Tonicities: 1° Esophoria at distance.

Orthophoria at near.

The fundi, media, pupillary reactions, versions, rotations, lids, conjunctiva, etc., appeared negative.

The Keratometer indicated a half diopter astigmatism, and this was confirmed skiametrically in the right eye only, the left eye showing a neutral movement. The net dynamic findings substantiated the static and subjectively he accepted

O.D. +0.50 D.Cyl. Axis 75—20/20

O.S. +0.50 D.Cyl. Axis 105—20/20

Tonicities were: Orthophoria at distance and 2° esophoria at near. Additional spherical power to the subjective findings did not affect the phorias and the cross cylinder tests did not help to elicit more plus power. The ductions were: Adduction 15°, Abduction 2°, Superduction 2°, Infractuction 2°.

The negative fusion reserve was 14/8; positive fusion reserve 20/14.

I prescribed a temporary correction based on the subjective findings and advised orthoptic exercises to develop the fusion faculty and stereopsis which were so weak that it took him over a minute to realize the acts.

Further investigation into the act of binocular vision and binocular perception disclosed more data and on May 16, 1935, I commenced training.

The program which I mapped out in this case was consistent with the diagnosis and the etiological factors. The diagnosis arrived at was that the boy had adduction insufficiency with reflex condition in the abduction muscles. The lowered visual acuity in the right eye was of spasmodic nature. Treatment therefor had to be directed along more than one line and, as the following program shows, it was arranged to take care of all the needs.

1. Base-in exercises for fusion and duction.
2. Base-in and base-out training for the development of Fusion Amplitude.
3. Visual acuity exercises for right eye mostly. (Use V.A.2 cards.)
4. Exercise accommodation only. (This exercise may be utilized first.)
5. Develop versions and rotations.
6. Develop stereopsis and measure quality and quantity.

SUPPLEMENTARY TRAINING:

1. Duction, both Adduction and Abduction development, during the entire program.
2. Right suppression and alternate suppression exercises.

In view of the fact that the young man was to take a preliminary physical examination for qualification and he had less than two weeks in which to bring his vision up to the required 20/20, uncorrected, I gave him treatments every day and on May 26th his visual acuity without correction in the right eye was 20/20 plus. On June 3, 1935, he took the preliminary visual examination and passed it. His fusion faculty is quite well developed and he has 15% stereopsis. His adduction is 30° O.U. and his abduction is 5° O.U. We have two weeks left before the young man's appearance for the qualifying examination and I expect to continue the daily exercises and to increase the stereopsis and fusion to the highest possible level. One of the daily treatments is with the "Shock Duction" slides. These slides have four pictures on them, two upper and two lower. They come in both, base-in and base-out series, and are in varying ducting powers. With fusion of the two upper and the two lower pictures established, a high amount of either abductive or adductive power is brought into use. This is analagous to the constant changes which our eyes undergo when changing the focus from one point to another. In addition, there is a strong fusion urge and the cards are stereoscopic. I find that by using this method of "Shock Duction" I get results which are more lasting and in less time. In putting the patient through such a routine, I do nothing less than emulate his daily habits.

The modern treatment of muscle imbalances is an educative process. If mechanical contrivances are employed and the muscles subjected to the mechanical stimulations, the educative phase is manifested in the various stimulators in the form of targets. It is the amount of convergence or divergence which the eye muscles are forced to exert in order to create a single image of the two targets that forces innervational impulse and gives increased vitality to the affected muscles, but the brain, where these impressions are registered, must be made ready to receive them, interpret them and to retain them.

When training the ocular muscles and muscular anomalies, it is well to remember that old and accepted visual habits must be supplanted, if not changed altogether. In order to accomplish that, new habits must be developed and ingrained so intensely that the mind will accept them in preference to the old ones, and retain them. The mind must be made conscious of the variations between the old and the new and it must be taught to select the latter. All this can be accomplished through persistent education and by media with which the mind—or the areas in the mind which respond to visual perception, are familiar. In muscular imbalances anomalous habits have been taken on and developed into normal. In the re-educative process these abnormal functions are taken up and corrected.

Aided by various physical corrective procedures, the ocular muscles acquire a different tone and together with the psychic training received, the new habit becomes individually accepted and the re-education becomes a successful accomplishment. This was demonstrated in the cases cited and is being shown in the cases following.

Mr. B. L., 16 years old was referred to me for orthoptic training by an ophthalmologist who refracted the boy and prescribed:

O.D. +0.50 D.Sph.⊂+0.50 D.Cyl. Axis 90—20/20 V.A.
O.S. +2.00 D.Sph.⊂+3.00 D.Cyl. Axis 85—1/200– V.A.

There is about 10° of left convergent squint without correction which is hardly noticeable with the glasses. Vision without correction in the left eye is the same as with, although peripherally he could see 10/200–, either way. No binocular perception. Near point vision with correction is limited to reading large newspaper headline type a few inches from the eyes. There is no pathology and the fields are normal.

The program outlined in this case is as follows: For the beginning the training was limited to amblyopia only, the remainder of the program will be mapped out as progress is made.

1. Amblyopia Training:
   a. Light Flashing—white and red filter, and the pinhole disc.
   b. Macular Fixation Development.
      1. Circling Letters.
      2. Tracing Pictures.
   c. Visual Acuity Cards.
   d. Hand and Eye Co-ordination.

Training was started on May 11, 1935, and on the 22nd his visual acuity was increased to 10/200, central vision. To stimulate the macular area better, I constructed a stimulator from corrugated cardboard and with its aid the visual acuity was raised to 20/200 on May 29th. The stimulator flashes light into the macular region of the retina and the light being concentrated, its effectiveness is greatly intensified. The boy is now able to point out letters with more ease, his retinal fixation is becoming normalized. I cut out words and single letters of varying sizes from newspapers and pasted them on pieces of cards and have the boy read them aloud and trace them. The entire routine of treatment is directed toward developing his amblyopic eye and to re-educate its functional capacity and to make it permanent. To accomplish this, it will be necessary to repeat the training constantly for a long period of time and even as the training progresses and new and more difficult treatments are given, the primary treatments will be repeated nevertheless. The boy and his mother know of this and are giving me their full cooperation. For home work, I instructed the boy to circle letters using the left eye and I prescribed a frosted disc in a fit-over frame to be used during the home work and for several hours during the day.

I didn't insert the frosted blank into his regular frame as the vision in his amblyopic eye was too low to permit him safe commutation and also because it would interfere with his school work, but as his visual acuity is becoming higher, I am anticipating employing such a procedure, especially during the vacation period.

Mrs. R. G., a housewife, 30 years old, was operated on 10 years ago for a Right Esotropia of about 35°. This condition came to her at the age of three, after an attack of measles. The ophthalmologist who performed the operation overcorrected the muscles somewhat, hoping that there would be constriction when they healed fully. Mrs. R. G. now has a Right Exotropia of about 25°. She consulted an ophthalmologist and he referred her to me for orthoptic training. Before doing that, however, he examined her eyes and found that the lenses which she had, didn't require changing.

A thorough preliminary orthoptic examination disclosed interesting information. There appeared a false alternating exotropia in the left eye. There was no fusion, but there is simultaneous binocular fixation for several minutes at a time and there is a desire for fusion. There is right suppression. This was checked several times and was noticed especially when both eyes were made to fixate a single object and then a second one introduced, there is diplopia, but one image soon fades out. Both eyes appear straight when directed at an object, but the moment the object of regard is withdrawn, the eye turns outwards. The heterotropic eye, however, participates in the act of vision only occasionaly and then there is diplopia.

The visual acuity, uncorrected and with the old glasses was O.D. 20/40, O.S. 20/20, and she reads the Jaeger 1 type at 14 inches with the right eye. The media are clear and there is no pathology of any kind in the eye.

The task before me was to correct an anomaly of long standing and one created to compensate another condition. The program for handling this case had to be consistent with the condition, and the patient's age. While it followed the usual routine employed in such cases, supplementary treatments had to be devised from time to time in order to leave more lasting and more diversified impressions. In addition, the muscles being more or less in a refractory state, had to be exercised so as to obtain the greatest amount of benefit.

1. Amblyopia Training.
   a. On Visual Acuity Charts, focused at infinity.
   b. Near point reading.
   c. Macular fixation (circling, tracing).
2. Fusion Training.
   a. Binocular and monocular fixation.
   b. Base-in and base-out effect, with fusion.
   c. Base-in and base-out effect, with duction.
   d. Alternate fixation using colored pencils and cards.

3. Suppression Exercises for Right Eye and alternating.
4. Versions both on cards and by manual methods.
5. Ductions with and without prisms (ordinary and shock).
6. Stereoscopic exercises and fusion.
7. Peckham's technique of wearing prisms base-out over both eyes (and over right eye only with a frosted disc in left eye—our own application).
8. Monocular and Binocular (mostly) fixation throughout entire program to be done at each treatment.

This case was started on May 10, 1935, and on the 17th her visual acuity in the right eye was 20/30. I started fusion and duction training supplemented with monocular and binocular fixation. On June 10th she reported that the sense of diplopia is quite apparent and asked me if she should suppress the false image. She is fusing with 30° prism base-in and can hold the picture singly with 20° prism base-in, for a few minutes. There is definitely an apparent reduction in the degree of deviation. I called this fact to Mrs. S. G.'s attention and she told me that her husband has noticed the same thing. The patient is very anxious to have the right eye completely straight and is cooperating to the utmost. I prescribed, on May 17th, 8° prism base-out in the right eye and her own prescribed lens in the left. This I changed on the 20th to 8° base-out in right and 6° base-out in left eye. On May 27th I changed the bases of the prisms to IN, in both eyes and increased the powers to 10° in the right and 8° in the left.

Together with the fusion training I am also giving her suppression exercises, but I am doing it more with the intent of developing the visual acuity than for the breaking up of suppression, as there is still the squint apparent. The fact that there is feeling of diplopia is rather encouraging. By developing fusion and duction this condition may be eliminated and both eyes may become orthophoric and so remain. The task is a difficult one and the patient is fully aware of it. This is one point I make clear at the beginning of each case. I make no promise of amelioration. I do my utmost, with the patient's assistance, to effect correction.

Part of my program in correcting the eyes of Mrs. R. G. calls for wearing of prisms during the course of training. The wearing of prisms in muscular imbalances is not a new procedure, but Dr. Peckham in his book "Squints and Heterophorias, Vol. 1" introduces a new modus operandi in the use of correcting prisms. He recommends the placing of the prescription prisms with their bases over the stronger muscles. Thus, in convergent strabismus he would place them base-in; in divergent strabismus, base-out. The explanation given for such a procedure is quite logical and can be summed up in the following few words. "The fovea turns to prism base; the cornea to the apex." The prisms must be of sufficient strength to cause the eye to turn and must be changed frequently in order not to develop a new habit

I have tried this procedure for several weeks in the above mentioned

case and in another, convergent strabismus case, and the results have not been as anticipated. Whatever the reasons may be for this I am at a loss to explain. It seems that I have carried out every prescript in modus operandi and my patients have been zealous in observing the instructions. Perhaps the two cases in which this was used were not fit cases for such a technique. However, I shall continue trying new ideas and new methods, in my quest for amelioration of squints and amblyopias.

As will be inferred from the descriptions of the few cases cited and the discussion of the programs outlined, the methods of treatment are all based upon a similar line of reasoning. While it appears so on the surface, each case, nevertheless, had its own individual technique and reaction. In orthoptic work it is most advantageous to outline a program of training and to work along its plan. Variations are permissible and oftentimes absolutely necessary. But the foundation upon which the work is being based must be systematically carried out. The various training charts and cards could be interchanged or improvised and the tests suited to whatever instrument employed.

Successful conclusion of orthoptic cases depends not so much on the instruments used as on the methods employed and on the resourcefulness of the operator. An orthoptist to be successful must always have a few tricks up his sleeve and thoroughly understand his case. He must plan his method of procedure and he must have his case always at his finger's tips. The general progress of the case must be open before him at all times and any discrepancy noted and corrected. In orthoptics every weak link must be strengthened, if complete amelioration is to be expected. There seems to be no collateral or compensatory reaction by the eye itself and by the muscles. All functions must be developed and frequently one at a time. The re-education must be complete in every detail and the eye must be drilled to pass the test without further preparation. I say "the eye" in a general sense, for the re-education in orthoptics is not of the eye alone but of the entire visual apparatus. But since the reactions reach these sources through the eyes, I therefore take the liberty to generalize.

It must not be construed that the various programs as outlined in the cases mentioned are intended for the use with one type of instrument only. It so happens that I am using the instruments mentioned, but the programs can be adapted for any one of the various muscle instruments and the techniques carried out with as much success. Basically all instruments devised for the training of muscular anomalies have the same principle. The program is merely a plan of operation, a sort of blue print which is to be followed in building up the eyes and muscles and the entire visual apparatus.

DR. WILLIAM SMITH
260 SEAVER STREET
ROXBURY, MASS.

AMERICAN JOURNAL OF OPTOMETRY

Vol. 12 AUGUST, 1935 No. 8

EDITORS

DR. CAREL C. KOCH
1501 Foshay Tower
821 Marquette Avenue
Minneapolis, Minn.

DR. JACK I. KURTZ
1501 Foshay Tower
821 Marquette Avenue
Minneapolis, Minn.

Original papers, scientific communications, clinical reports, society proceedings, books for review, and correspondence should be sent to the Editor, Dr. Carel C. Koch.

Annual Subscription, $4.00 in Advance, Canada and Foreign, $5.00.
Single Copies, 40c.

Copy of advertisements must be sent in by the tenth of the month preceding their appearance. Subscriptions, applications for single copies, communications with reference to advertising or other business should be addressed to the Business Manager, Dr. Jack I. Kurtz, 1501 Foshay Tower, Minneapolis, Minn.

Published Monthly by the
American Journal of Optometry Publishing Association.

The Journal has no objection to the reprinting by other magazines of any of its articles, provided such reprints are properly credited to the Amerian Journal of Optometry.

THE DEVELOPMENT OF MYOPIA

In order to solve the question as to what causes the development of Myopia many interesting and some rather fantastic hypothesis and theories have been advanced. Some of these appear logical, others very illogical. Duke Elder gives the following list as possible causes:

(1) Predisposition—A weakness of the sclerotic and its inability to withstand the normal intraocular pressure without giving away and stretching.

(2) Near work—Bad ocular hygiene and physical debility.

(3) Continuation of Precocity—The eye shares with the brain the peculiarity of having a precocious growth. At the age of four the brain is 84% of its full size, the eye 78% and the rest of the body only 21%. In myopia this precocious growth seems to continue and a failure of the arresting influence to act.

(4) Calcium deficiency. Sir Arthur Keith, according to Duke Elder, points out that one of the controlling factors which regulate the activities of the fibroblastic cell (of which the sclera is made up) is the endocrine system especially the pituitary body. A calcium deficiency of the blood is common in Myopia. The growth and development of the

sclerotic is bound up with the growth and development of the fibroblastic cells and some derangement of this function may be a cause of Myopia.

(5) Nearwork—It has been shown statistically that myopia usually increases during the years of school life in a ratio greater than its mere age incidents warrants. Cohn found 1.4% in the lower grades of schools and the proportion gradually rose to 60% in the universities.

(6) Muscular pressure of the extrinsic muscles which press upon the eyeball in the act of convergence while the eye is used at near.

(7) Excess of Accommodation theory.

(8) The Ciliary pull upon the Choroid.

(9) Deficient accommodation in that the pumping action of the ciliary muscle through the scleral spur of Thomson in the canal of Schlemm is deficient, thus raising the tension by preventing the drainage of the aqueous.

(10) Obstruction to the outflow of fluid in the lympth spaces associated with the optic nerve head.

(11) Convergence excess, the effect of which is noticed by the muscles pressing against the globe of the eye. It is claimed by some that the recti muscles are the offenders while others claim the superior oblique are responsible.

(12) Excess of Mesoblastic vitreous material into the secondary optic vesicle.

(13) Excessive development of the retina.

(14) A shortening of the optic nerve which pulls upon the posterior pole of the eye.

(15) A softening of the posterior sclero-choroidal coat.

(16) The shape of the orbit.

(17) Increased intra-pupilary distance, which increases the convergence effort, which in turn increases the muscle pressure upon the globe of the eye.

(18) The action of gravity when the head is bent causes the elongation of the eyeball (by Levinsohn).

No one theory or hypothesis seems to give a real explanation as to the causation of myopia. We shall not attempt to discuss all of these at present. We shall confine ourselves to only one, namely, intra-ocular pressure.

Increased Intra-Ocular Pressure as a Cause of Myopia

Much has been written on this subject as a cause of the development of myopia and one would be inclined to accept this theory as an established fact. However, we must emphasize very strongly that the tonometric method is not very accurate for recording an absolute measure of the intra-ocular pressure, because the tonometer measures the state of tension of the cornea and the tunics of the eye which are kept in place by the intra-ocular pressure. The tension, however, is not identical with the pressure.

There is a variation in the relationship between the intra-ocular pressure and the tension of the eye. It varies with the radius of curvature, with the size of the eye and with the meridian measured. Again we must keep in mind that as the measurement is taken with the tonometer pressure is applied to the eyeball, this in turn increases the pressure within the eyeball and thus adds one more element of error which makes accurate measurement impossible.

While there have been developed of late some accurate methods of measuring intra-ocular pressure in the laboratory these methods can not be applied to the human eye clinically.

There are available some facts which tend to discredit the claim that intra-ocular pressure is causing the development of myopia.

(a) It is known that the pressure is somewhat higher in the first decade of life, than in adult life, yet we find that most myopia development starts at the end of the first decade and increases usually during the second and third decades when the intra-ocular pressure has decreased.

(b) There is a constant variation in the normal height of the pressure, varying from three to five mm., due to pulse and respiratory changes, accordingly we should find similar fluctuations in the amounts of myopia, or a periodic slight degree of myopia in emmetropic cases. This, however, is not in agreement with actual clinical observation.

(c) There is a diurnal variation in pressure. It is found that the intra-ocular pressure is higher in the morning and falls slowly but constantly until evening, and then gradually and constantly rises till morning.

(d) Equilibrium Mechanism. In the normal eye the pressure level is maintained relatively constant by that safety mechanism known as the canal of Schlemm. In view of the fact that the sclera is relatively non-elastic any changes that may take place in the contents volume of the eyeball immediately cause a change in pressure which is equalized by the activity of the canal of Schlemm, that is an outflow of fluid through this canal takes place.

(e) Elasticity of the Sclera. Numerous research workers studied the degree of elasticity of the sclera, while their findings are considerably at variance with another, they, however, tend to show that the sclera has very little elasticity. It was shown that when the intra-ocular pressure was raised from 13 to 70 mm. of mercury the volume increase amounted only to 0.007% of the original. This small increase can hardly be considered as a factor capable of stretching the sclera to a very great extent.

The above discussion would indicate that intra-ocular pressure should not be considered as a major factor causing the development of myopia. Some of the other theories and hyopthesis claimed to be the cause of myopia will be discussed in these pages in the near future.

J. I. K.

BOOK NOTICES

OPHTHALMOSCOPY, RETINOSCOPY AND REFRACTION, by Dr. F. A. Fisher. Published by F. A. Davis Co., 1916 Cherry Street, Philadelphia, Pa. Cloth binding, 290 pages, 262 illustrations, 48 color plates, 1931. Price $2.50.

In writing this book on Ophthalmoscopy, Fisher intended it as a text-book for students and general practitioners to prepare themselves for the practice of Ophthalmology and Refraction. He believes that with some reading and a little practice any general practitioner should be able to refract his patients. He clearly expresses his views in the preface to the first edition where he states as follows:

"This book has been written with the intention of teaching medical practitioners and students the practical use of the ophthalmoscope and retinoscope, with easy application of methods of study to the detection of diseases of the interior of the eye and for fitting of glasses when they are indicated.

"By mastering the methods here described and equipping himself with the necessary instruments there is no reason why the general practitioner should not prescribe so as to correct the common errors of refraction and become proficient with the ophthalmoscope."

To accomplish this end the author devotes 104 out of the 290 pages to the description of the use of the ophthalmoscope, giving numerous colored plates to illustrate the different types of abnormal fundus.

Such important subjects as cataract, glaucoma, color blindness and taking of the visual field are all covered in forty pages. Evidently Fisher does not attach real importance to any of these subjects and naturally the embryonic refractionist that will spring up from studying this book will attach to them still less importance.

The important subjects of presbyopia and muscular abnormalities are treated in two separate chapters of *three* pages each. The author does not by any means overlook the importance of oculo-prism treatment and devotes an entire paragraph of nine lines to this all important and complicated subject.

The last three chapters cover retinoscopy and its application, lens measurements and frame fitting, and the final chapter on the newer methods of ophthalmic diagnosis was written by Dr. Robert Von der Heydt and covers red-free light ophthalmoscopy, Gulstrand binocular Ophthalmoscope and slit lamp microscopy. J. I. K.

Write for sample of

New "Continuation Card"

Give name of your distributor

N. P. BENSON OPTICAL CO., Inc.

ESTABLISHED 1913

MINNEAPOLIS, MINN.

DULUTH LACROSSE ABERDEEN

EAU CLAIRE WAUSAU BISMARCK RAPID CITY

WHICH BIFOCAL?

AND WHY?

A number of questions confront the refractionist each time he prescribes bifocal lenses. Which bifocal should be used? Why?—How high should the segments be? How much inset?—Should the lens be tilted? How much?—How far from the eyes should the lens be? The comfort and efficiency of the bifocals depend almost as much on the correct answering of these questions as on the correctness of the refraction.

WALCO BIFOCAL SERVICE

You may have these questions answered accurately and scientifically by using the Walco Bifocal Service Here's how to do it. Send us a full and detailed prescription. We will analyze your prescription and return to you a complete report covering the above questions The report will be unbiased. This service is free to refractionists, in the territories we serve, and details no obligation. Use it whenever there is the slightest doubt about bifocal lenses.

THE WALMAN OPTICAL COMPANY

229 MEDICAL ARTS BLDG.

MINNEAPOLIS, MINN.

FARGO GRAND FORKS ST. PAUL